1,161,615

PATENT SPECIFICATION

NO DRAWINGS

1,161,615

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COMPLETE SPECIFICATION

Improvements in Copper-Nickel Alloys

We, LANGLEY ALLOYS LIMITED, a Body Corporate duly organised under the Laws of Great Britain of Station Road, Langley, Slough, in the County of Buckingham, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to Copper-Nickel alloys and is an improvement in or modification of that forming the subject of Specification No. 999,438.

In the aforementioned Application, Copper-Nickel alloys are described having the composition:—

Nickel	More than 15% and up to 32%
Aluminium	More than 0.5% but less than 5% and less than one-sixth of the Nickel content
Manganese	More than 3% but less than 10% and less than half the Nickel content
Iron	0.2% to 3%
with optionally	0.2% to 3% Niobium and/or Silicon
Balance	substantially all Copper

It has now been found that a considerable enhancement in the response to precipitation hardening can be achieved by replacing part of the Nickel with additional Iron. Thus, this modification provides a low magnetic permeability Copper-Nickel alloy having the following composition by weight:—

Nickel	6.5% — 25.0%
Aluminium	1.0% — 4.99%
Manganese	3.0% — 8.5%
Iron	5.0% — 12.0%
Chromium	Up to 3%
with optionally	0.2% — 3% Niobium and/or Silicon
Balance	Copper

and wherein the Nickel content is less than four times the Iron content and with the sum of the Nickel and Iron contents being at least four times the Aluminium content.

The addition of up to 3% Chromium will confer a refining action in the grain of the alloy when it is cast.

The beneficial effect of increased Iron content is so marked that the high ratio of Nickel to Aluminium is no longer essential, although the sum of the Nickel and Iron contents must be more than four times the Aluminium content, which is at least 1% and less than 5% while the Manganese content is 3% to 8.5%, the balance being Copper except for unavoidable impurities. Notwithstanding the increased Iron content, the alloys remain substantially non-magnetic.

Examples of the alloy compositions covered by this modification are shown in the following Tables 1, 2, 2A and 3, from which it will be noted that the Examples demonstrate a remarkably good combination of proof stress, strength and Izod Impact Value, but the most significant feature is the considerable increase in proof stress which can be achieved after casting or hot working, by precipitation hardening at a temperature in the range 350°—650°C. as shown in Table 1.

In the hot worked condition the modified alloys show improvements in properties at elevated temperatures, those for Alloy 5 of Table 1 being as follows:—

Example No.	Condition	Test Temperature °C.	0.1% Proof Stress Tons/Sq.in.	Tensile Strength Tons/Sq.in.	Elong. %	Redn. in Area %
5	Hot rolled plus 4 hrs. @ 550°C.	20	41.2	54.4	18.0	42.5
		300	—	47.6	17.5	35.0
		400	—	47.25	14.0	17.5
		450	—	46.2	11.0	17.5

These alloys of higher Iron content also possess advantages when produced as sand castings as evidenced by Table 2.

The Examples 15 to 18 in Table 2A which included Chromium exhibited a perceptible refinement in their grain.

However, as shown by a comparison of Example 19 with Examples 20 to 23 in Table 3, the addition of Chromium improves the ductility of the cast alloys at elevated temperatures. The addition of Chromium also confers improved weldability on the alloys.

TABLE 1—WROUGHT ALLOYS

Example No.	% Analysis						Condition	0.1% Proof Stress Tons/sq.in.	Tensile Strength Tons/sq.in.	Elong. %	Redn. in Area %	Izod Value ft.lbs.
	Copper	Nickel	Aluminium	Manganese	Iron	Addit. Element						
1	Balance	17.2	1.71	5.15	5.24		Hot rolled	28.8	41.6	32.0	76.0	116
							Hot rolled+4 hrs. @ 550°C.	40.0	54.4	21.0	57.5	46
2	Balance	15.0	1.65	3.8	6.2		Hot rolled	26.4	39.6	42.0	72.0	119
							Hot rolled+4 hrs. @ 550°C.	40.0	55.0	22.0	52.0	67
							Rolled Bar Heat treated@ 900°C. and Water quenched	12.0	30.4	42.0	70.0	—
							Rolled Bar Heat treated@ 900°C. and Water quenched cold rolled 47%	42.4	47.6	16.0	66.0	59
							Rolled Bar Heat treated@ 900°C. and Water quenched cold rolled 47% then heat treated 4 hrs. @ 500°C.	53.6	61.2	12.0	50.0	56
3	Balance	18.0	1.59	4.70	8.8		Hot rolled	28.0	42.4	30.0	72.0	115
							Hot rolled+4 hrs. @ 550°C.	41.6	56.0	20.0	55.0	78
4	Balance	17.5	1.60	4.25	7.7		Hot rolled	26.4	40.8	34.0	75.0	115
							Hot rolled+4 hrs. @ 550°C.	40.8	55.4	21.0	55.0	87
5	Balance	12.0	1.66	4.10	6.36		Hot rolled	26.4	39.2	30.0	72.0	101
							Hot rolled+4 hrs. @ 550°C.	41.2	54.4	18.0	42.5	71
6	Balance	11.2	2.61	4.85	6.15		Hot rolled	29.6	42.4	30.0	70.0	113
							Hot rolled+4 hrs. @ 550°C.	40.8	53.6	18.0	35.0	50
7	Balance	16.3	1.35	3.7	6.72	Niobium 0.27	Hot rolled+4 hrs. @ 550°C.	42.0	54.8	21.0	60.0	53
8	Balance	16.7	1.78	5.0	6.25	Niobium 0.34	Hot rolled+4 hrs. @ 550°C.	41.5	57.0	28.0	55.0	62

TABLE 2—SAND CAST ALLOYS

Example No.	% Analysis						Condition	0.1% Proof Stress Tons/ sq.in.	Tensile Strength Tons/ in.	Elong. %	Redn. in Area	Izod Value ft.lbs.
	Copper	Nickel	Aluminium	Manganese	Iron	Additional Elements						
9	Balance	14.9	1.76	4.85	6.35		As cast	17.0	32.0	30.0	37.5	44
							As cast plus precipitation hardening for 4 hrs. @ 550°C.	22.4	36.0	19.0	22.5	38
10	Balance	13.1	1.27	4.70	6.6	Niobium 0.37	As cast+4 hrs. @ 550°C.	18.5	35.5	26.0	30.0	30
11	Balance	12.0	1.88	4.02	6.72		As cast	15.4	30.8	37.0	40.0	
							As cast+precipitation Hardening for 4 hrs. @ 550°C.	22.4	38.5	20.0	25.0	
12	Balance	11.6	1.94	4.25	6.62		As cast+precipitation hardening for 4 hrs. @ 550°C.	22.5	39.5	15.5	—	43
13	Balance	11.4	1.65	4.10	7.02		As cast+precipitation hardening for 4 hrs. @ 550°C.	23.0	40.3	20.0	20.0	—
14	Balance	15.8	2.03	4.70	5.70		As cast	20.0	34.4	32.0	—	37
							As cast+precipitation hardening for 4 hrs. @ 550°C.	28.0	41.2	18.0	—	30

TABLE 2A

SAND CAST ALLOYS CONTAINING CHROMIUM

Example No.	Chemical Composition						Condition	0.1% Proof Stress Tons/ Sq.in.	Tensile Strength Tons/ Sq.in.	Elong. %	Izod Value ft.lbs.
	Copper %	Nickel %	Aluminium %	Manganese %	Iron %	% Additional Elements					
						Chromium					
15	Balance	12.1	2.37	8.65	5.89	0.44	As cast	17.8	36.0	36.0	35
16	„	12.1	2.37	8.65	5.89	0.44	As cast+precipitation hardening for 4 hrs. @ 550°C. Air cooled	21.8	40.2	23.0	29.0
17	„	12.1	2.56	8.05	5.8	0.72	As cast+precipitation hardening for 4 hrs. @ 550°C. Air cooled	22.0	39.2	22.0	27.0
18	„	14.5	2.45	8.35	7.81	0.86	As cast+precipitation hardening for 4 hrs. @ 550°C. Air cooled	19.0	38.0	29.0	32

TABLE 3

CAST ALLOYS AT ELEVATED TEMPERATURES WITH AND WITHOUT CHROMIUM

Example No.	Copper %	Nickel %	Manganese %	Iron %	Aluminium %	Chromium %	Condition (All 1" dia. Sand Cast Bar) A.C.=Air Cooled)	Test Temp.	0.1% Proof Stress Tons/ Sq.in.	Tensile Strength Tons/ Sq.in.	Elong. %	Redn. in Area %
19	Balance	12.6	5.3	6.25	1.81	Nil	Heat treatment 4 hrs. @ 550°C. A.C.	350°C.	—	29.4	4.0	6.0
20	„	11.8	5.10	6.72	1.69	1.17	Heat treatment 4 hrs. @ 550°C. A.C.	Room	19.1	36.3	21.5	
21	„	11.8	5.10	6.72	1.69	1.17	Heat treatment 4 hrs. @ 550°C.	350°C.	—	29.0	9.0	12.0
22	„	11.8	5.10	6.72	1.69	1.17	As cast condition	350°C.	—	23.4	10.0	15.0
23	„	11.4	5.0	6.72	1.56	2.22	Heat treatment 4 hrs. @ 550°C. A.C.	350°C.	—	29.9	10.0	12.0

WHAT WE CLAIM IS:—

1. A low magnetic permeability Copper-Nickel alloy having the following composition by weight:—

Nickel	6.5% — 25.0%
Aluminium	1.0% — 4.99%
Manganese	3.0% — 8.5%
Iron	5.0% — 12.0%
Chromium	Up to 3%
with optionally	0.2% — 3% Niobium and/or Silicon
Balance	Copper

and wherein the Nickel content is less than four times the Iron content and with the sum of the Nickel and Iron contents being at least four times the Aluminium content.

2. A copper-Nickel alloy according to Claim 1 when, in the cast condition, it has been subjected to precipitation hardening in the temperature range 350°C. to 650°C.

3. A Copper-Nickel alloy according to Claim 1 and which following hot working has been subjected to precipitation hardening in the temperature range 350°C. to 650°C.

4. A Copper-Nickel alloy according to Claim 1 produced and subjected to precipitation hardening substantially as hereinbefore described in any of the Examples given in Tables 1, 2, 2A or 3.

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